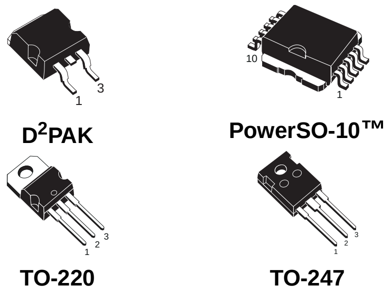
# VNB35NV04 / VNP35NV04
# VNV35NV04 / VNW35NV04

## "OMNIFET II": FULLY AUTOPROTECTED POWER MOSFET

| TYPE | $R_{DS(on)}$ | $I_{lim}$ | $V_{clamp}$ |
|---|---|---|---|
| VNB35NV04<br>VNP35NV04<br>VNV35NV04<br>VNW35NV04 | 10 mΩ (*) | 30 A | 40 V |

(*) For PowerSO-10 only

- LINEAR CURRENT LIMITATION
- THERMAL SHUT DOWN
- SHORT CIRCUIT PROTECTION
- INTEGRATED CLAMP
- LOW CURRENT DRAWN FROM INPUT PIN
- DIAGNOSTIC FEEDBACK THROUGH INPUT PIN
- ESD PROTECTION
- DIRECT ACCESS TO THE GATE OF THE POWER MOSFET (ANALOG DRIVING)
- COMPATIBLE WITH STANDARD POWER MOSFET



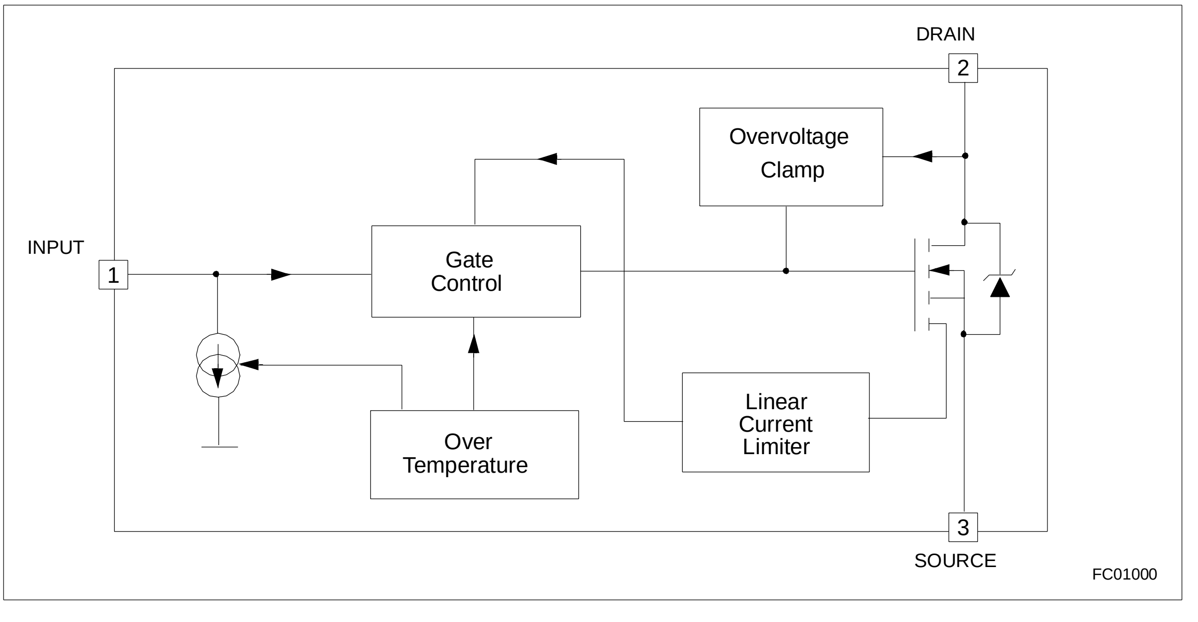

**ORDER CODES:**

| | |
|---|---|
| $D^2$PAK | VNB35NV04 |
| TO-220 | VNP35NV04 |
| PowerSO-10™ | VNV35NV04 |
| TO-247 | VNW35NV04 |

### DESCRIPTION

The VNB35NV04, VNP35NV04, VNV35NV04, VNW35NV04 are monolithic devices designed in STMicroelectronics VIPower M0-3 Technology, intended for replacement of standard Power MOSFETS from DC up to 25KHz applications. Built in thermal shutdown, linear current limitation and overvoltage clamp protect the chip in harsh environments. Fault feedback can be detected by monitoring the voltage at the input pin.

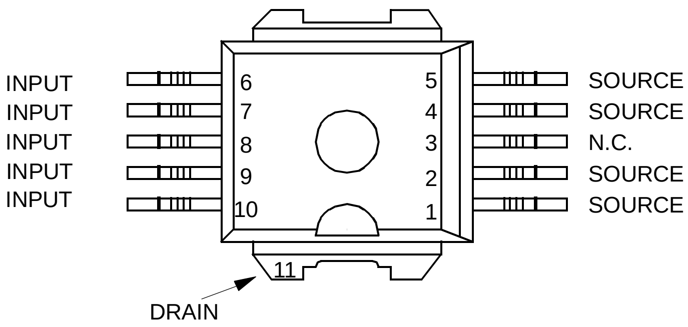
### BLOCK DIAGRAM



## ABSOLUTE MAXIMUM RATING

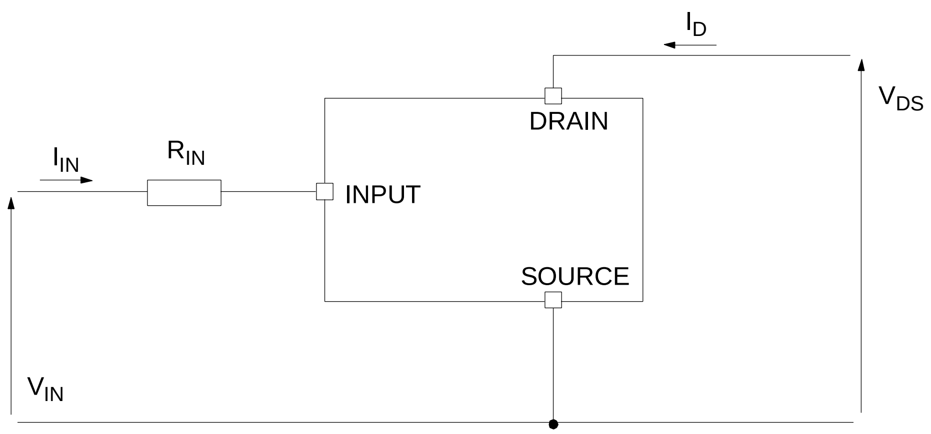
| Symbol | Parameter | Value | | | | Unit |
|---|---|---|---|---|---|---|
| | | PowerSO-10™ | $D^2PAK$ | TO-220 | TO-247 | |
| $V_{DS}$ | Drain-source Voltage ($V_{IN}$=0V) | Internally Clamped | | | | V |
| $V_{IN}$ | Input Voltage | Internally Clamped | | | | V |
| $I_{IN}$ | Input Current | +/-20 | | | | mA |
| $R_{IN\ MIN}$ | Minimum Input Series Impedance | 4.7 | | | | Ω |
| $I_D$ | Drain Current | Internally Limited | | | | A |
| $I_R$ | Reverse DC Output Current | -30 | | | | A |
| $V_{ESD1}$ | Electrostatic Discharge (R=1.5KΩ, C=100pF) | 4000 | | | | V |
| $V_{ESD2}$ | Electrostatic Discharge on output pin only (R=330Ω, C=150pF) | 16500 | | | | V |
| $P_{tot}$ | Total Dissipation at $T_c$=25°C | 125 | 125 | 125 | 208 | W |
| $T_j$ | Operating Junction Temperature | Internally limited | | | | °C |
| $T_c$ | Case Operating Temperature | Internally limited | | | | °C |
| $T_{stg}$ | Storage Temperature | -55 to 150 | | | | °C |

## CONNECTION DIAGRAM (TOP VIEW)




(*) For the pins configuration related to TO-220, TO-247, $D^2PAK$, see outlines at page 1.

## CURRENT AND VOLTAGE CONVENTIONS



## THERMAL DATA

| Symbol | Parameter | | Value | | | | Unit |
|---|---|---|---|---|---|---|---|
| | | | PowerSO-10™ | D2PAK | TO-220 | TO-247 | |
| $R_{thj-case}$ | Thermal Resistance Junction-case | MAX | 1 | 1 | 1 | 0.6 | °C/W |
| $R_{thj-amb}$ | Thermal Resistance Junction-ambient | MAX | 50(*) | 50(*) | 50 | 30 | °C/W |

(*) When mounted on a standard single-sided FR4 board with 50mm$^2$ of Cu (at least 35 µm thick) connected to all DRAIN pins.

## ELECTRICAL CHARACTERISTICS (-40°C < $T_j$ < 150°C, unless otherwise specified)

OFF

| Symbol | Parameter | Test Conditions | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|
| $V_{CLAMP}$ | Drain-source Clamp Voltage | $V_{IN}$=0V; $I_D$=15A | 40 | 45 | 55 | V |
| $V_{CLTH}$ | Drain-source Clamp Threshold Voltage | $V_{IN}$=0V; $I_D$=2mA | 36 | | | V |
| $V_{INTH}$ | Input Threshold Voltage | $V_{DS}$=$V_{IN}$; $I_D$=1mA | 0.5 | | 2.5 | V |
| $I_{ISS}$ | Supply Current from Input Pin | $V_{DS}$=0V; $V_{IN}$=5V | | 100 | 150 | µA |
| $V_{INCL}$ | Input-Source Clamp Voltage | $I_{IN}$=1mA<br>$I_{IN}$=-1mA | 6<br>-1.0 | 6.8 | 8<br>-0.3 | V |
| $I_{DSS}$ | Zero Input Voltage Drain Current ($V_{IN}$=0V) | $V_{DS}$=13V; $V_{IN}$=0V; $T_j$=25°C<br>$V_{DS}$=25V; $V_{IN}$=0V | | | 30<br>75 | µA |

ON

| Symbol | Parameter | Test Conditions | Max | | Unit |
|---|---|---|---|---|---|
| | | | PowerSO-10 | $D^2$PAK TO-220 / TO-247 | |
| $R_{DS(on)}$ | Static Drain-source On Resistance | $V_{IN}$=5V; $I_D$=15A; $T_j$=25°C<br>$V_{IN}$=5V; $I_D$=15A; $T_j$=150°C | 10<br>20 | 13<br>24 | mΩ |

## ELECTRICAL CHARACTERISTICS (continued) ($T_j$=25°C, unless otherwise specified)

DYNAMIC

| Symbol | Parameter | Test Conditions | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|
| $g_{fs}$ (*) | Forward Transconductance | $V_{DD}$=13V; $I_D$=15A | | 35 | | S |
| $C_{OSS}$ | Output Capacitance | $V_{DS}$=13V; f=1MHz; $V_{IN}$=0V | | 1300 | | pF |

SWITCHING

| Symbol | Parameter | Test Conditions | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|
| $t_{d(on)}$ | Turn-on Delay Time | $V_{DD}$=15V; $I_D$=15A<br>$V_{gen}$=5V; $R_{gen}$=$R_{IN\ MIN}$=4.7Ω<br>(see figure 1) | | 150 | 500 | ns |
| $t_r$ | Rise Time | | | 840 | 2500 | ns |
| $t_{d(off)}$ | Turn-off Delay Time | | | 980 | 3000 | ns |
| $t_f$ | Fall Time | | | 600 | 1500 | ns |
| $t_{d(on)}$ | Turn-on Delay Time | $V_{DD}$=15V; $I_D$=15A<br>$V_{gen}$=5V; $R_{gen}$=2.2KΩ<br>(see figure 1) | | 4 | 12 | µs |
| $t_r$ | Rise Time | | | 27 | 100 | µs |
| $t_{d(off)}$ | Turn-off Delay Time | | | 34 | 120 | µs |
| $t_f$ | Fall Time | | | 31 | 110 | µs |
| $(di/dt)_{on}$ | Turn-on Current Slope | $V_{DD}$=15V; $I_D$=15A<br>$V_{gen}$=5V; $R_{gen}$=$R_{IN\ MIN}$=4.7Ω | | 18 | | A/µs |
| $Q_i$ | Total Input Charge | $V_{DD}$=12V; $I_D$=15A; $V_{IN}$=5V<br>$I_{gen}$ =2.13mA (see figure 5) | | 118 | | nC |

SOURCE DRAIN DIODE

| Symbol | Parameter | Test Conditions | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|
| $V_{SD}$ (*) | Forward On Voltage | $I_{SD}$=15A; $V_{IN}$=0V | | 0.8 | | V |
| $t_{rr}$ | Reverse Recovery Time | $I_{SD}$=15A; dI/dt=100A/µs<br>$V_{DD}$=30V; L=200µH<br>(see test circuit, figure 2) | | 400 | | ns |
| $Q_{rr}$ | Reverse Recovery Charge | | | 1.4 | | µC |
| $I_{RRM}$ | Reverse Recovery Current | | | 7 | | A |

PROTECTIONS (-40°C < $T_j$ < 150°C, unless otherwise specified)

| Symbol | Parameter | Test Conditions | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|
| $I_{lim}$ | Drain Current Limit | $V_{IN}$=6V; $V_{DS}$=13V | 30 | 45 | 60 | A |
| $t_{dlim}$ | Step Response Current Limit | $V_{IN}$=6V; $V_{DS}$=13V | | 50 | | µs |
| $T_{jsh}$ | Overtemperature Shutdown | | 150 | 175 | 200 | °C |
| $T_{jrs}$ | Overtemperature Reset | | 135 | | | °C |
| $I_{gf}$ | Fault Sink Current | $V_{IN}$=5V; $V_{DS}$=13V; $T_j$=$T_{jsh}$ | 10 | 15 | 20 | mA |
| $E_{as}$ | Single Pulse Avalanche Energy | starting $T_j$=25°C; $V_{DD}$=24V<br>$V_{IN}$=5V; $R_{gen}$=$R_{IN\ MIN}$=4.7Ω; L=24mH<br>(see figures 3 & 4) | 1.7 | | | J |

(*) Pulsed: Pulse duration = 300µs, duty cycle 1.5%

**PROTECTION FEATURES**

During normal operation, the INPUT pin is electrically connected to the gate of the internal power MOSFET through a low impedance path.

The device then behaves like a standard power MOSFET and can be used as a switch from DC up to 25KHz. The only difference from the user's standpoint is that a small DC current $I_{ISS}$ (typ. 100µA) flows into the INPUT pin in order to supply the internal circuitry.

The device integrates:

- OVERVOLTAGE CLAMP PROTECTION:

internally set at 45V, along with the rugged avalanche characteristics of the Power MOSFET stage give this device unrivalled ruggedness and energy handling capability. This feature is mainly important when driving inductive loads.

- LINEAR CURRENT LIMITER CIRCUIT:

limits the drain current $I_D$ to $I_{lim}$ whatever the INPUT pin voltages is. When the current limiter is active, the device operates in the linear region, so power dissipation may exceed the capability of the heatsink. Both case and junction temperatures increase, and if this phase lasts long enough, junction temperature may reach the overtemperature threshold $T_{jsh}$.

- OVERTEMPERATURE AND SHORT CIRCUIT PROTECTION:

these are based on sensing the chip temperature and are not dependent on the input voltage. The location of the sensing element on the chip in the power stage area ensures fast, accurate detection of the junction temperature. Overtemperature cutout occurs in the range 150 to 190 °C, a typical value being 170 °C. The device is automatically restarted when the chip temperature falls of about 15°C below shut-down temperature.

- STATUS FEEDBACK:

in the case of an overtemperature fault condition ($T_j > T_{jsh}$), the device tries to sink a diagnostic current $I_{gf}$ through the INPUT pin in order to indicate fault condition. If driven from a low impedance source, this current may be used in order to warn the control circuit of a device shutdown. If the drive impedance is high enough so that the INPUT pin driver is not able to supply the current $I_{gf}$, the INPUT pin will fall to 0V. **This will not however affect the device operation: no requirement is put on the current capability of the INPUT pin driver except to be able to supply the normal operation drive current $I_{ISS}$.**

Additional features of this device are ESD protection according to the Human Body model and the ability to be driven from a TTL Logic circuit.

**Fig.1:** Switching Time Test Circuit for Resistive Load

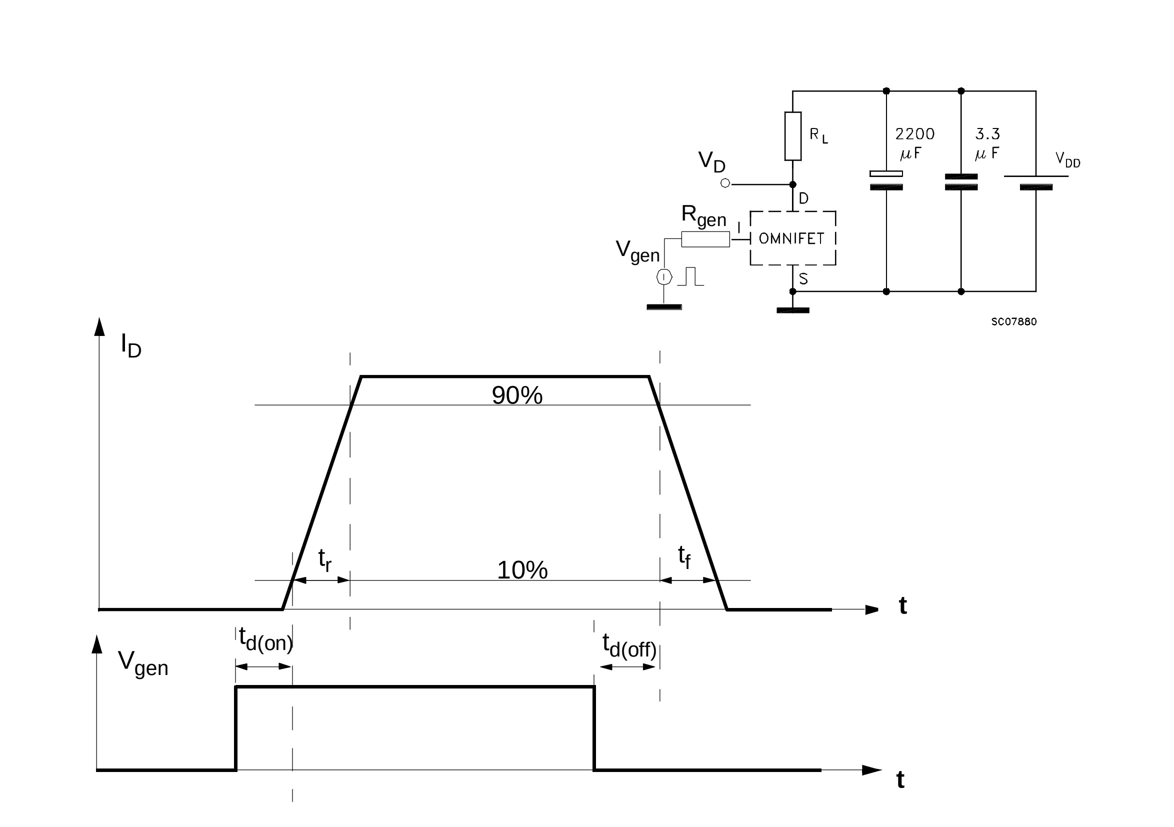



**Fig.2:** Test Circuit for Diode Recovery Times

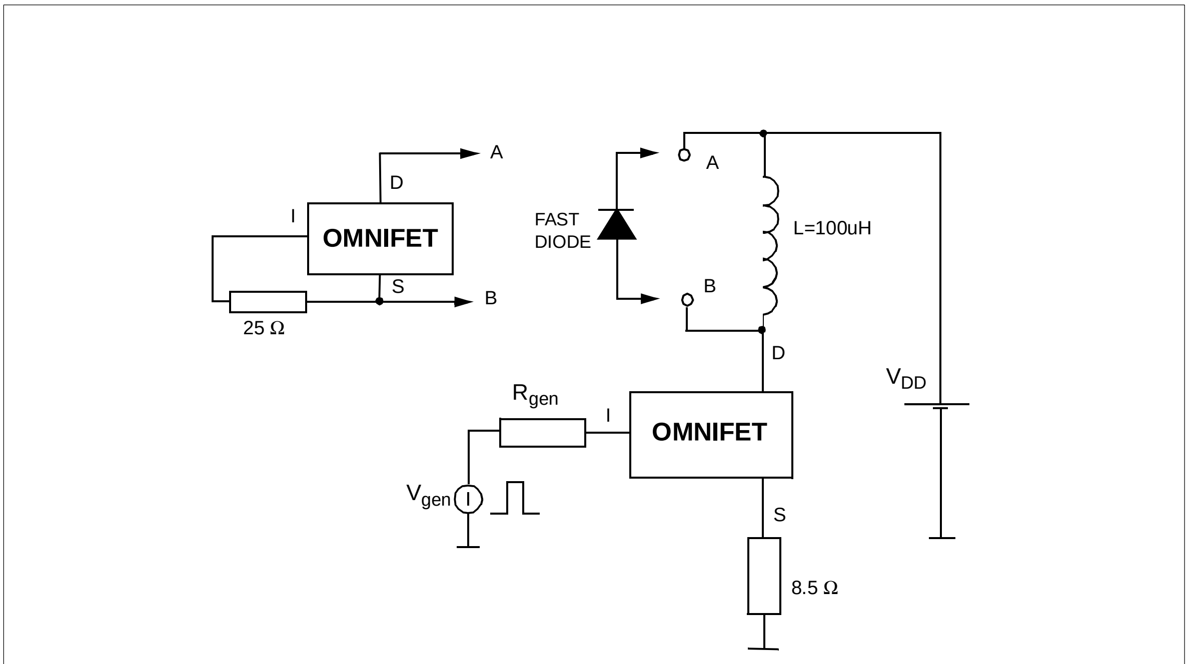


**Fig. 3:** Unclamped Inductive Load Test Circuits

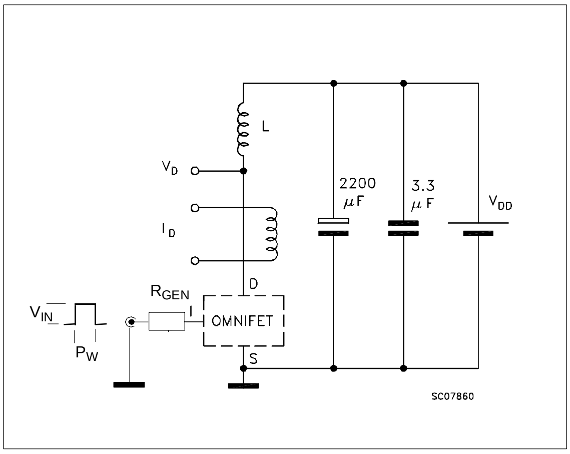



**Fig. 4:** Unclamped Inductive Waveforms

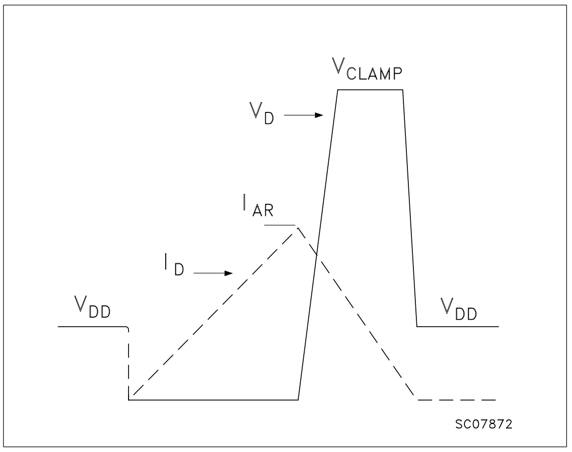



**Fig. 5:** Input Charge Test Circuit

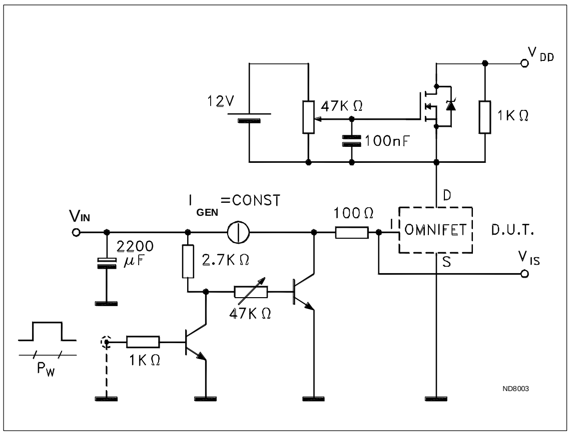



**Fig 6 :** Thermal Impedance for TO-220

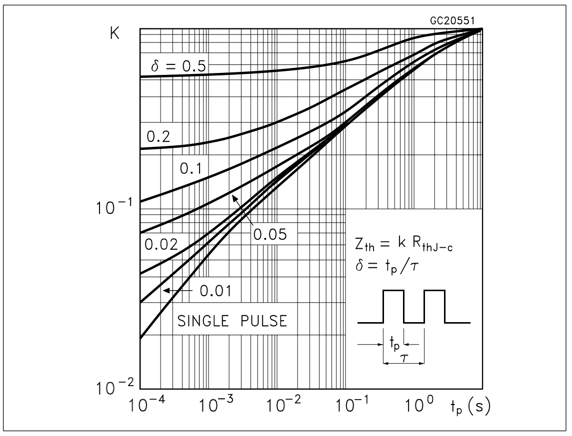
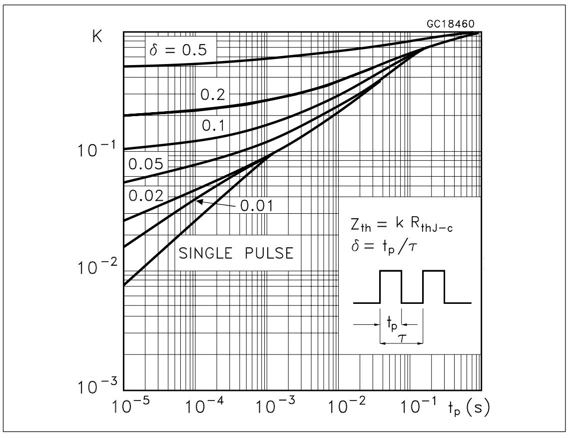
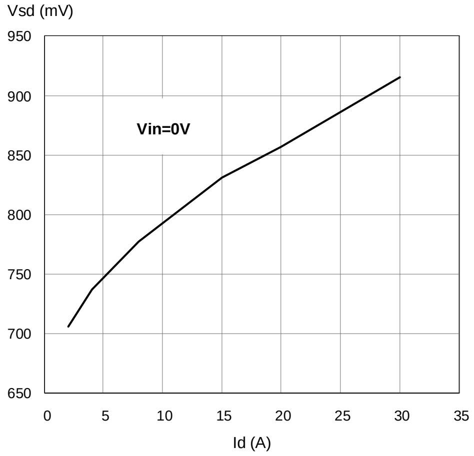


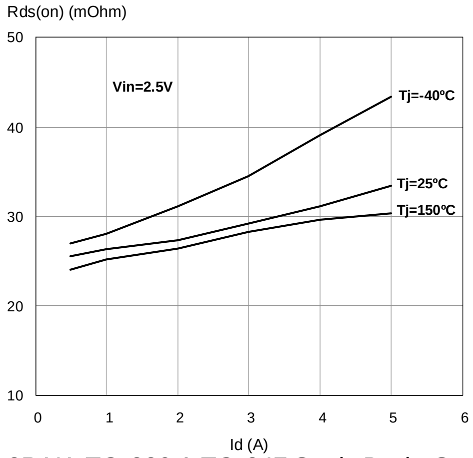

**Fig. 7:**Thermal Impedance for TO-247



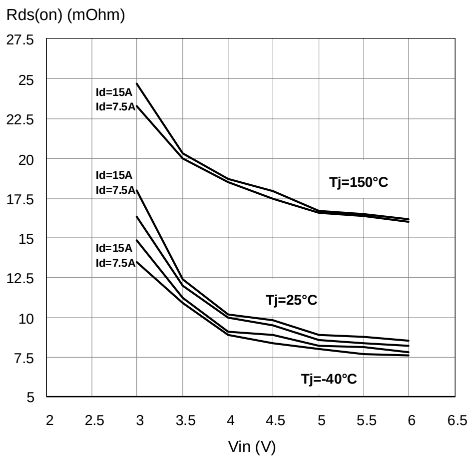
### Source-Drain Diode Forward Characteristics



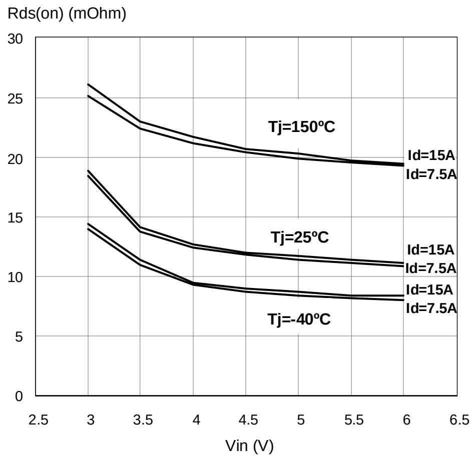

### Static Drain Source On Resistance



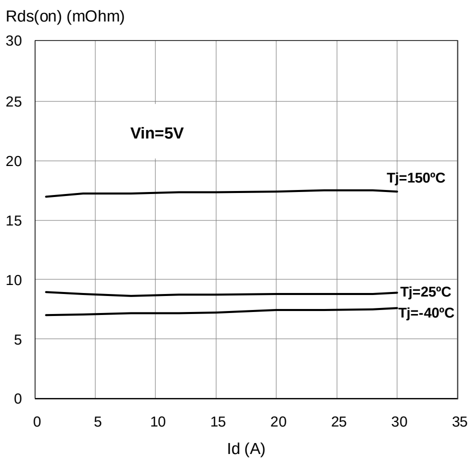

### PowerSO-10 Static Drain-Source On resistance Vs. Input Voltage



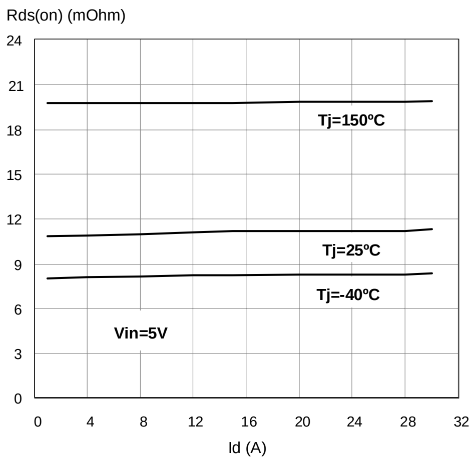

### D2PAK, TO-220 & TO-247 Static Drain-Source On resistance Vs. Input Voltage



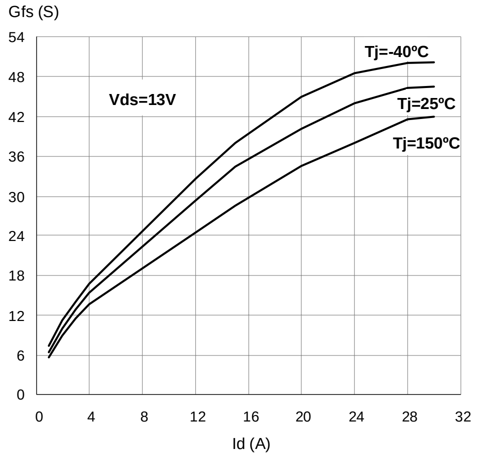

### PowerSO-10 Static Drain-Source On Resistance Vs. Id



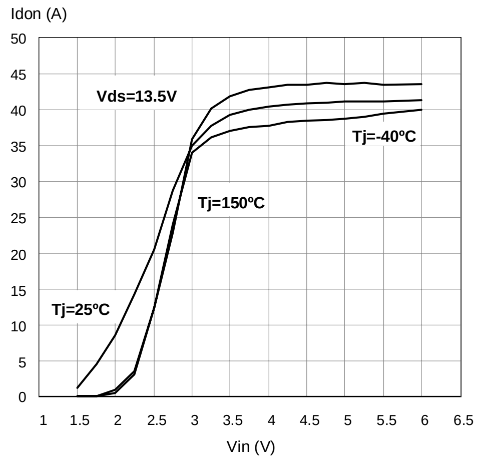

### D2PAK, TO-220 & TO-247 Static Drain-Source On Resistance Vs. Id



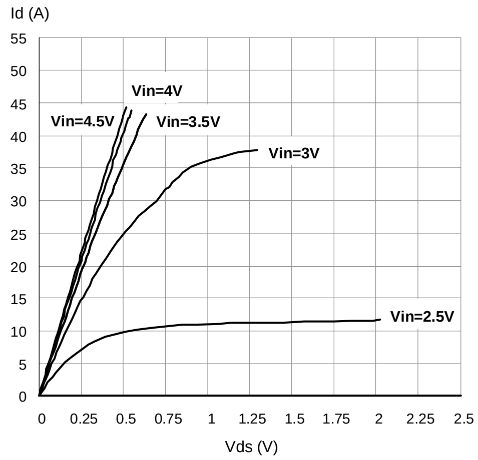
## Transconductance



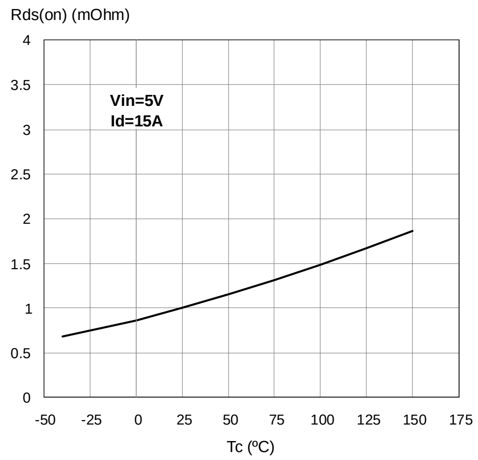

## Transfer Characteristics



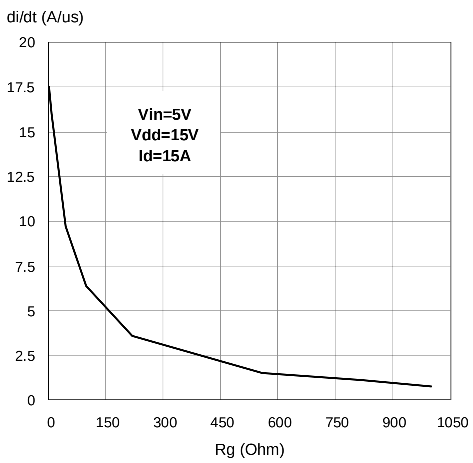

## Output Characteristics



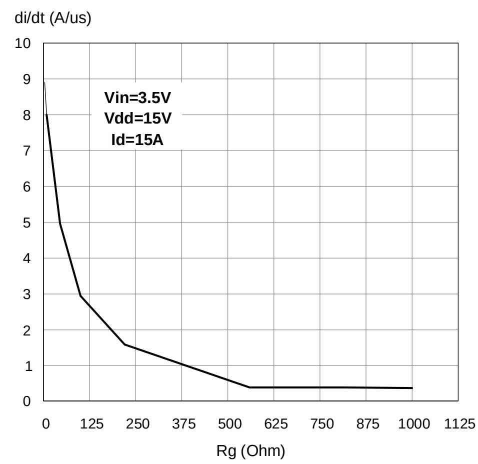

## Normalized On Resistance Vs. Temperature



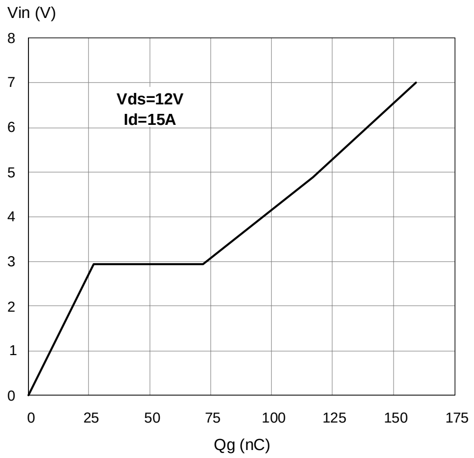

## Turn On Current Slope



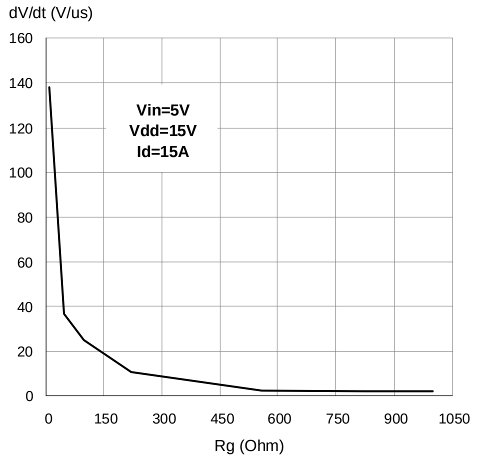

## Turn On Current Slope



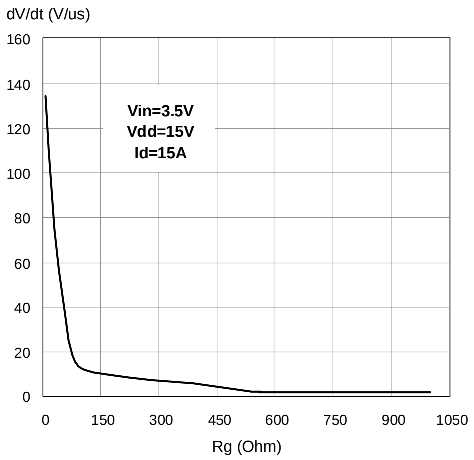
Input Voltage Vs. Input Charge



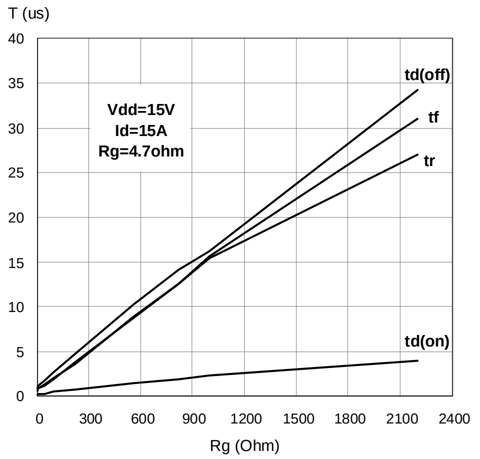

Turn off drain source voltage slope



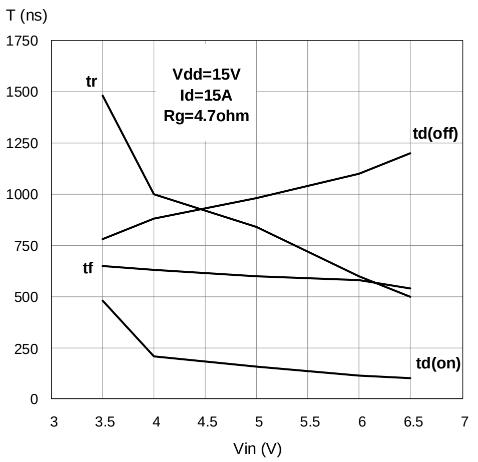

Turn Off Drain-Source Voltage Slope



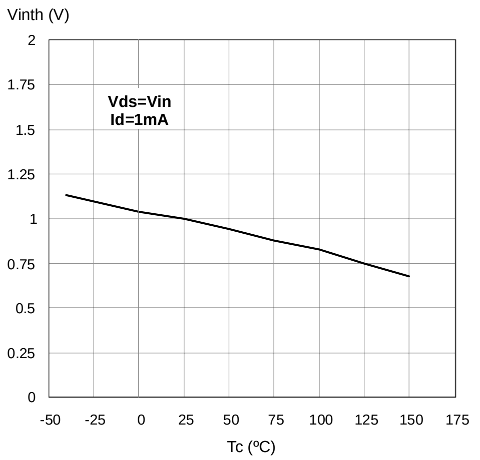

Switching Time Resistive Load



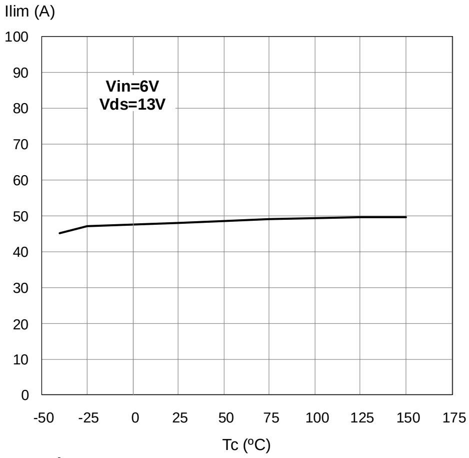

Switching Time Resistive Load



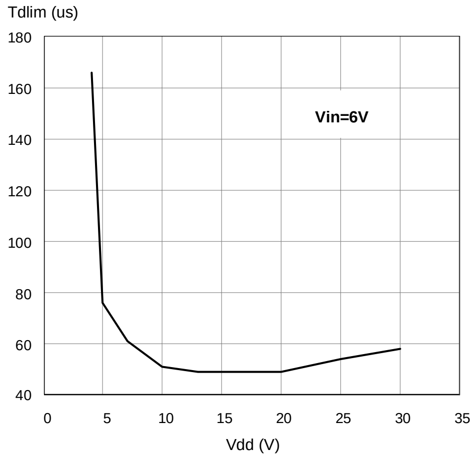

Normalized Input Threshold Voltage Vs. Temperature



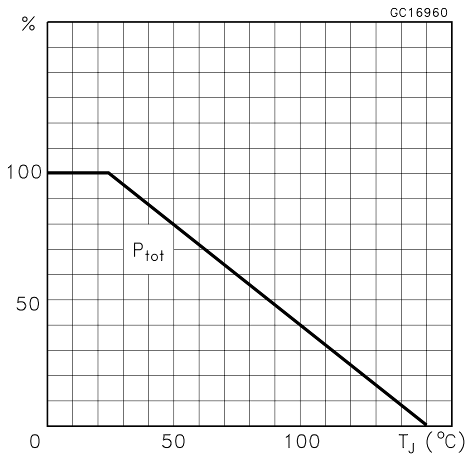
## Current Limit Vs. Junction Temperature




## Step Response Current Limit

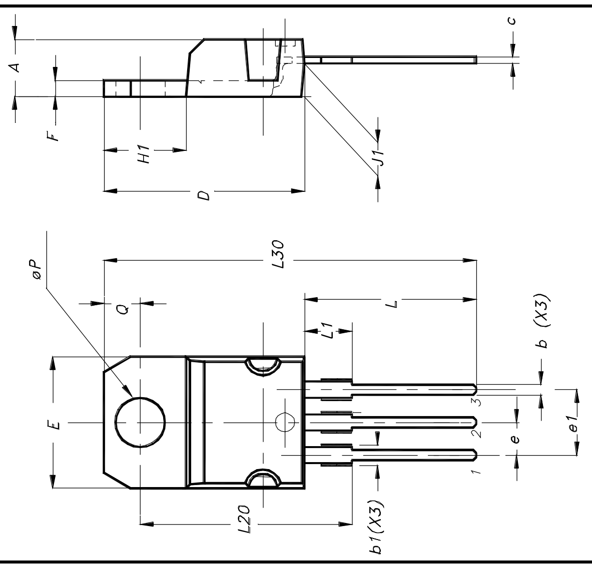



## Derating Curve



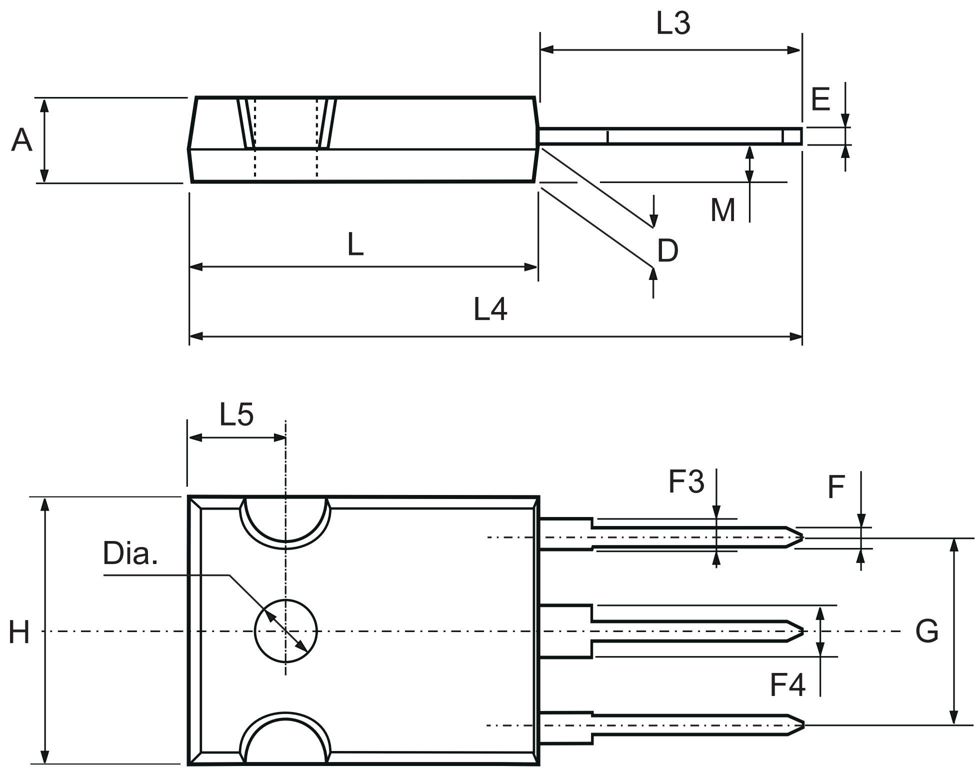
## TO-220 MECHANICAL DATA

| DIM. | mm. | | |
|---|---|---|---|
| | MIN. | TYP | MAX. |
| A | 4.40 | | 4.60 |
| b | 0.61 | | 0.88 |
| b1 | 1.15 | | 1.70 |
| c | 0.49 | | 0.70 |
| D | 15.25 | | 15.75 |
| E | 10 | | 10.40 |
| e | 2.40 | | 2.70 |
| e1 | 4.95 | | 5.15 |
| F | 1.23 | | 1.32 |
| H1 | 6.20 | | 6.60 |
| J1 | 2.40 | | 2.72 |
| L | 13 | | 14 |
| L1 | 3.50 | | 3.93 |
| L20 | | 16.40 | |
| L30 | | 28.90 | |
| ∅P | 3.75 | | 3.85 |
| Q | 2.65 | | 2.95 |
| Package Weight | 1.9Gr. (Typ.) | | |



# TO-247 MECHANICAL DATA

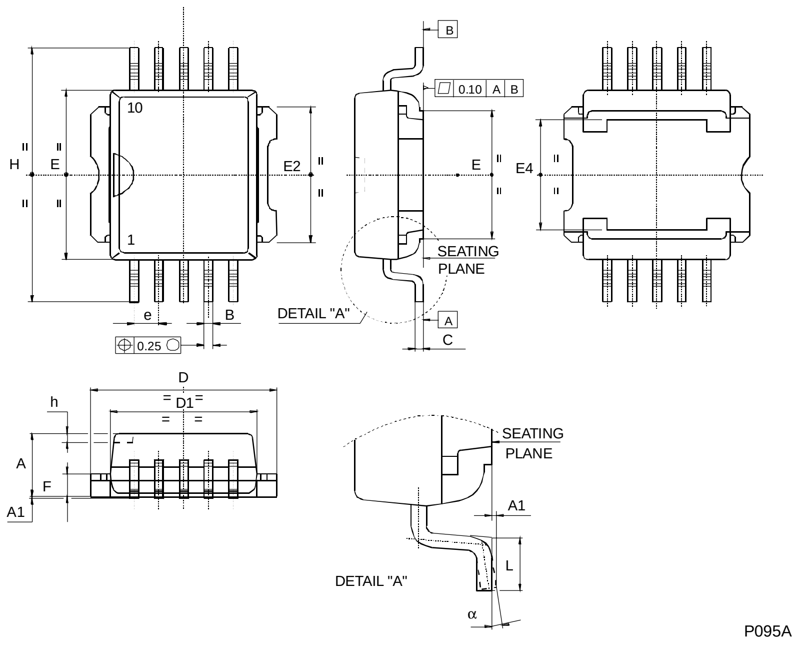
| DIM. | mm. | | | inch | | |
|---|---|---|---|---|---|---|
| | MIN. | TYP | MAX. | MIN. | TYP. | MAX. |
| A | 4.7 | | 5.3 | 0.185 | | 0.209 |
| D | 2.2 | | 2.6 | 0.087 | | 0.102 |
| E | 0.4 | | 0.8 | 0.016 | | 0.031 |
| F | 1 | | 1.4 | 0.039 | | 0.055 |
| F3 | 2 | | 2.4 | 0.079 | | 0.094 |
| F4 | 3 | | 3.4 | 0.118 | | 0.134 |
| G | | 10.9 | | | 0.429 | |
| H | 15.3 | | 15.9 | 0.602 | | 0.626 |
| L | 19.7 | | 20.3 | 0.776 | | 0.779 |
| L3 | 14.2 | | 14.8 | 0.559 | | 0.582 |
| L4 | | 34.6 | | | 1.362 | |
| L5 | | 5.5 | | | 0.217 | |
| M | 2 | | 3 | 0.079 | | 0.118 |
| Dia. | 3.55 | | 3.65 | 0.140 | | 0.144 |



## PowerSO-10™ MECHANICAL DATA

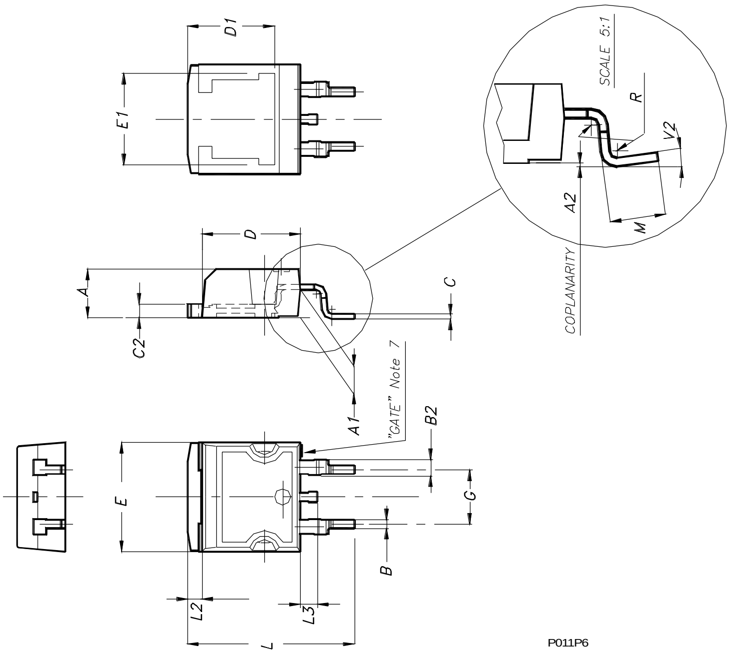
| DIM. | mm. | | | inch | | |
|---|---|---|---|---|---|---|
| | MIN. | TYP | MAX. | MIN. | TYP. | MAX. |
| A | 3.35 | | 3.65 | 0.132 | | 0.144 |
| A (*) | 3.4 | | 3.6 | 0.134 | | 0.142 |
| A1 | 0.00 | | 0.10 | 0.000 | | 0.004 |
| B | 0.40 | | 0.60 | 0.016 | | 0.024 |
| B (*) | 0.37 | | 0.53 | 0.014 | | 0.021 |
| C | 0.35 | | 0.55 | 0.013 | | 0.022 |
| C (*) | 0.23 | | 0.32 | 0.009 | | 0.0126 |
| D | 9.40 | | 9.60 | 0.370 | | 0.378 |
| D1 | 7.40 | | 7.60 | 0.291 | | 0.300 |
| E | 9.30 | | 9.50 | 0.366 | | 0.374 |
| E2 | 7.20 | | 7.60 | 0.283 | | 300 |
| E2 (*) | 7.30 | | 7.50 | 0.287 | | 0.295 |
| E4 | 5.90 | | 6.10 | 0.232 | | 0.240 |
| E4 (*) | 5.90 | | 6.30 | 0.232 | | 0.248 |
| e | | 1.27 | | | 0.050 | |
| F | 1.25 | | 1.35 | 0.049 | | 0.053 |
| F (*) | 1.20 | | 1.40 | 0.047 | | 0.055 |
| H | 13.80 | | 14.40 | 0.543 | | 0.567 |
| H (*) | 13.85 | | 14.35 | 0.545 | | 0.565 |
| h | | 0.50 | | | 0.002 | |
| L | 1.20 | | 1.80 | 0.047 | | 0.070 |
| L (*) | 0.80 | | 1.10 | 0.031 | | 0.043 |
| α | 0º | | 8º | 0º | | 8º |
| α (*) | 2º | | 8º | 2º | | 8º |

(*) Muar only POA P013P

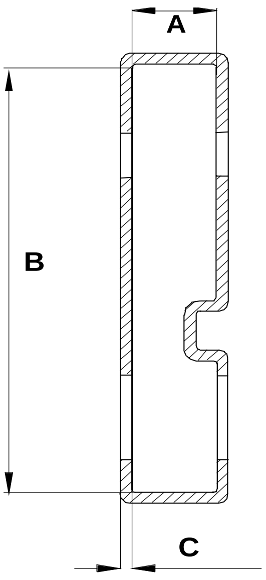


## $D^2$PAK MECHANICAL DATA

| DIM. | mm. | | |
|---|---|---|---|
| | MIN. | TYP | MAX. |
| A | 4.4 | | 4.6 |
| A1 | 2.49 | | 2.69 |
| A2 | 0.03 | | 0.23 |
| B | 0.7 | | 0.93 |
| B2 | 1.14 | | 1.7 |
| C | 0.45 | | 0.6 |
| C2 | 1.23 | | 1.36 |
| D | 8.95 | | 9.35 |
| D1 | | 8 | |
| E | 10 | | 10.4 |
| E1 | | 8.5 | |
| G | 4.88 | | 5.28 |
| L | 15 | | 15.85 |
| L2 | 1.27 | | 1.4 |
| L3 | 1.4 | | 1.75 |
| M | 2.4 | | 3.2 |
| R | | 0.4 | |
| V2 | 0º | | 8º |



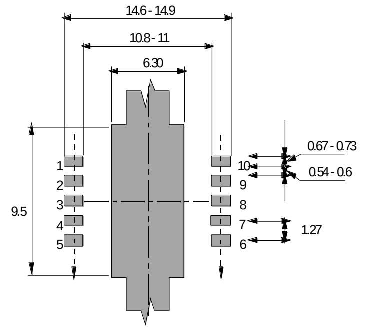
## TO-220 TUBE SHIPMENT (no suffix)



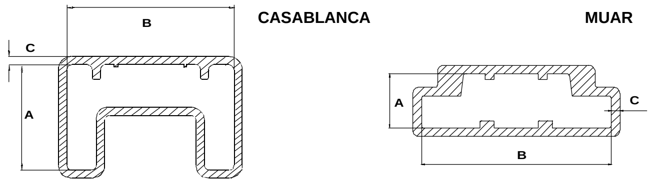

| | |
|---|---|
| **Base Q.ty** | 50 |
| **Bulk Q.ty** | 1000 |
| **Tube length (± 0.5)** | 532 |
| **A** | 5.5 |
| **B** | 31.4 |
| **C (± 0.1)** | 0.75 |

All dimensions are in mm.

## PowerSO-10™ SUGGESTED PAD LAYOUT



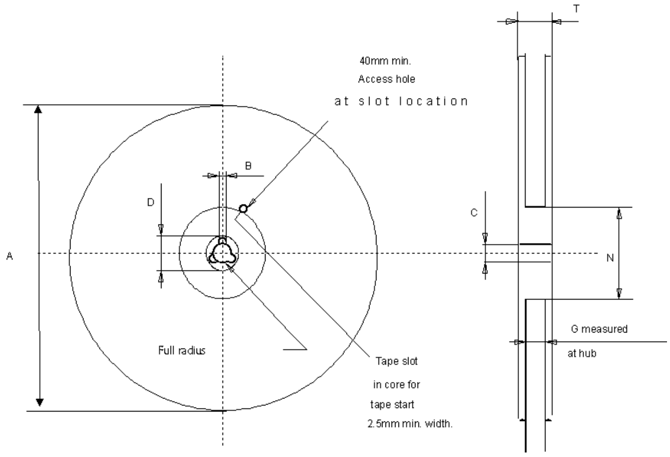

## TUBE SHIPMENT (no suffix)




All dimensions are in mm.

| | Base Q.ty | Bulk Q.ty | Tube length (± 0.5) | A | B | C (± 0.1) |
|---|---|---|---|---|---|---|
| **Casablanca** | 50 | 1000 | 532 | 10.4 | 16.4 | 0.8 |
| **Muar** | 50 | 1000 | 532 | 4.9 | 17.2 | 0.8 |

## TAPE AND REEL SHIPMENT (suffix “13TR”)




### REEL DIMENSIONS

| | |
|---|---|
| **Base Q.ty** | 600 |
| **Bulk Q.ty** | 600 |
| **A (max)** | 330 |
| **B (min)** | 1.5 |
| **C (± 0.2)** | 13 |
| **F** | 20.2 |
| **G (+ 2 / -0)** | 24.4 |
| **N (min)** | 60 |
| **T (max)** | 30.4 |

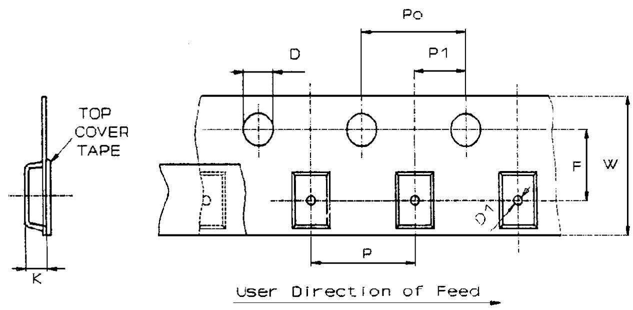
All dimensions are in mm.

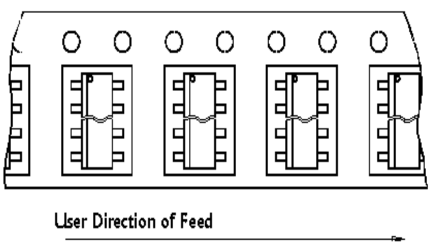
### TAPE DIMENSIONS

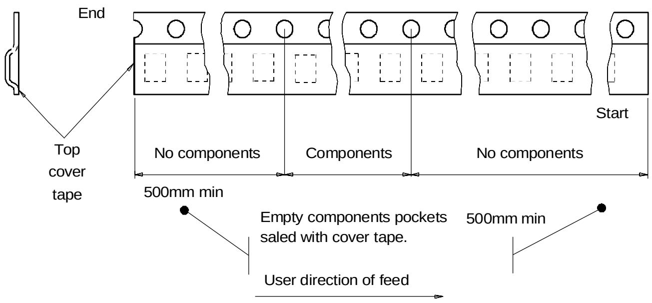
According to Electronic Industries Association (EIA) Standard 481 rev. A, Feb 1986

| | | |
|---|---|---|
| **Tape width** | **W** | 24 |
| **Tape Hole Spacing** | **P0 (± 0.1)** | 4 |
| **Component Spacing** | **P** | 24 |
| **Hole Diameter** | **D (± 0.1/-0)** | 1.5 |
| **Hole Diameter** | **D1 (min)** | 1.5 |
| **Hole Position** | **F (± 0.05)** | 11.5 |
| **Compartment Depth** | **K (max)** | 6.5 |
| **Hole Spacing** | **P1 (± 0.1)** | 2 |

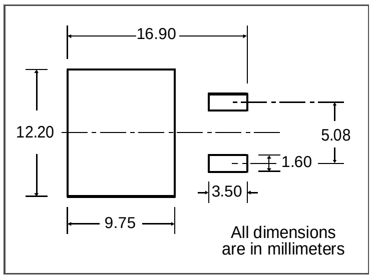
All dimensions are in mm.



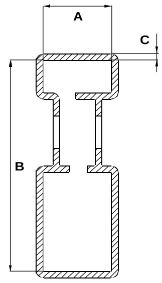



## D²PAK FOOTPRINT



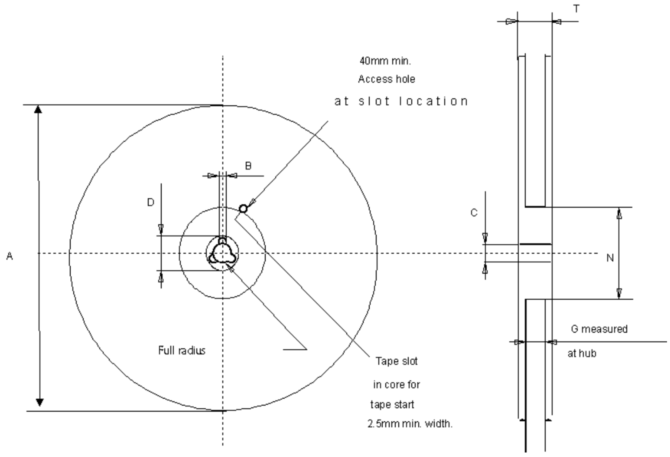

## TUBE SHIPMENT (no suffix)




| | |
|---|---|
| **Base Q.ty** | 50 |
| **Bulk Q.ty** | 500 |
| **Tube length (± 0.5)** | 532 |
| **A** | 6 |
| **B** | 21.3 |
| **C (± 0.1)** | 0.6 |

All dimensions are in mm.

## TAPE AND REEL SHIPMENT (suffix "13TR")




### REEL DIMENSIONS

| | |
|---|---|
| **Base Q.ty** | 1000 |
| **Bulk Q.ty** | 1000 |
| **A (max)** | 330 |
| **B (min)** | 1.5 |
| **C (± 0.2)** | 13 |
| **F** | 20.2 |
| **G (+ 2 / -0)** | 24.4 |
| **N (min)** | 60 |
| **T (max)** | 30.4 |

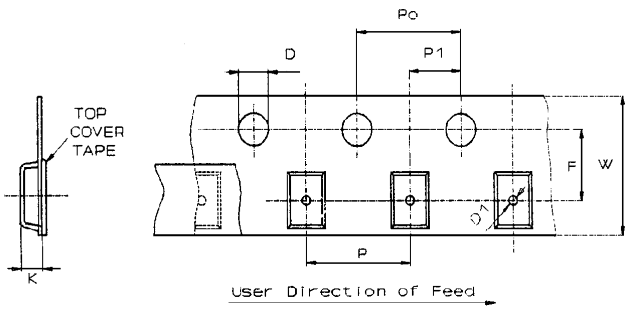
All dimensions are in mm.

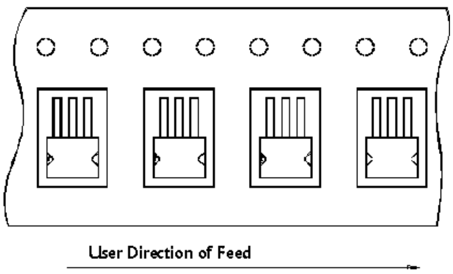
### TAPE DIMENSIONS

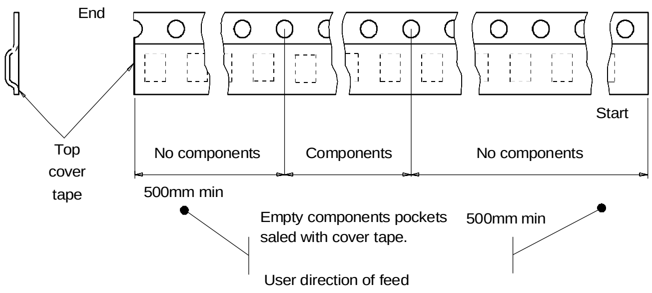
According to Electronic Industries Association (EIA) Standard 481 rev. A, Feb 1986

| | | |
|---|---|---|
| **Tape width** | **W** | 24 |
| **Tape Hole Spacing** | **P0 (± 0.1)** | 4 |
| **Component Spacing** | **P** | 16 |
| **Hole Diameter** | **D (± 0.1/-0)** | 1.5 |
| **Hole Diameter** | **D1 (min)** | 1.5 |
| **Hole Position** | **F (± 0.05)** | 11.5 |
| **Compartment Depth** | **K (max)** | 6.5 |
| **Hole Spacing** | **P1 (± 0.1)** | 2 |

All dimensions are in mm.



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